



Accounting for Labor Productivity Puzzle

Kateryna Bornukova*

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Abstract

In the recent decades aggregate labor productivity in the U.S. became countercyclical (labor productivity puzzle). At the same time the U.S. experienced dramatic changes in the structure of households due to increased female labor force participation. I show that changes in the household structure and corresponding changes in labor supply behavior can explain the labor productivity puzzle. I build a model with heterogeneous one- and two-earner households and aggregate technology shocks and calibrate it to the current U.S. data. I impose the household structure change in the model and show that the behavior of labor productivity changes from procyclical to countercyclical, as in the U.S. I also show that individual labor supply volatility depends on the role of the earner in the household. Increase in the proportion of multiple-earner households leads to increase in aggregate labor supply volatility.

Keywords: business cycles, family labor supply, multiple-earner households

JEL Classification: C68, E32, E24, J22

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1 Introduction

Aggregate labor productivity has changed its cyclical behavior over the last 60 years from weakly procyclical to countercyclical - the literature refers to this fact as the labor productivity puzzle. At the same time the household structure in the U.S. underwent significant changes, in particular a shift from one-earner to two-earner households. This paper argues that changes in household composition affected the cyclical behavior of productivity through labor supply decisions and may explain the labor productivity puzzle.

Table 1: Correlations of aggregate labor productivity with output and aggregate hours

Correlation with:	1950:q1-1979:q4	1980:q1-2009:q4
Output	0.10	-0.27
Hours	-0.38	-0.68

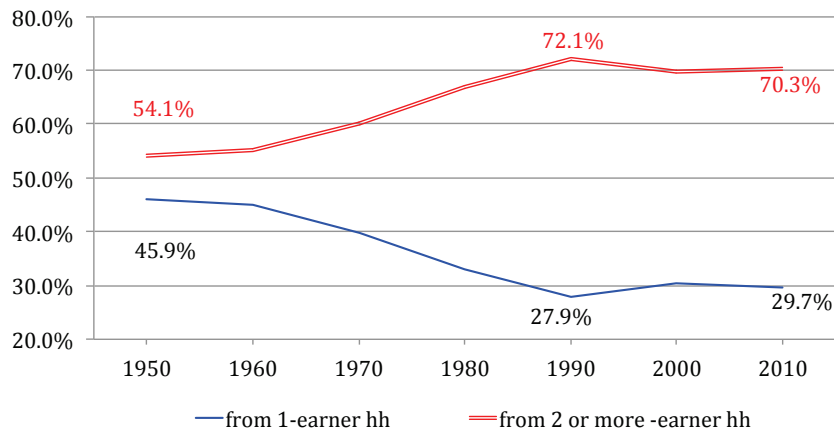
U.S. data. All variables are logged and detrended with HP filter

Labor productivity puzzle manifests itself in the change of the correlation of aggregate productivity with output from 0.10 in 1950-1979 to -0.27 in 1980-2009 (see Table 1; Gali and van Rens (2014) offer more evidence on the change of cyclical behavior of productivity). Aggregate labor productivity increased over the Great Recession, which generated interest in the problem (Mulligan, 2011; Ramey, 2012). At the same time the puzzling negative comovement of hours and productivity, well known before (Hansen and Wright, 1992; Christiano and Eichenbaum, 1992), became more pronounced (Stroh, 2009). The correlation between hours and productivity changed from -0.38 to -0.68 , contrary to the predictions of workhorse macroeconomic models.

Simultaneously with the change in labor productivity behavior, the structure of American households changed. Increased female labor force participation challenged the traditional family labor division as described by Becker (1981). As a result, more and more workers in the labor force come from the two-earner households (see Fig. 1). I argue that their behavior is different from the behavior of the sole earners. In particular, both primary and secondary earners from a multiple-earner households can have more elastic labor supply. This is especially true for the secondary earners, whose role in family monetary income is limited, and hence they can substitute into home production if necessary.

The standard RBC model can generate countercyclical aggregate labor productivity when amended for a two-person household. Intuitively, labor supply becomes much more

Figure 1: Labor force by household type in the U.S.



elastic and volatile over the cycle if the representative household consists of two people, as the secondary earner can easily substitute into home production. In recessions aggregate productivity experiences positive effects as labor supply contracts more significantly than in the one-person model and the contraction is mainly in the less productive part of the labor supply. These effects dominate the decline in TFP, and aggregate labor productivity increases. Since the proportion of two-earner households increased significantly since 1960, this change might explain the switch in the behavior of productivity.

Can the observed increase in the share of two-earner households explain the change in the correlations of aggregate labor productivity with output and aggregate hours? To answer this question I construct a heterogeneous agents model featuring one- and two-earner households. Each household is assigned one of the three types: one-person, two-person one-earner or two-earner household. Each assigned earner can decide to drop out of the labor market and divides time between leisure, working on the market and working at home, while assigned non-earners only have the options of leisure and home production. Agents in all households differ in productivity. The economy is only subject to aggregate technology shock, and there are no shocks to individual productivities. I calibrate the model to the current U.S. economy, and expose it to the exogenous change in the household structure (proportions of three household types) identical to the change which happened in the U.S. from 1950 till 2000.

I compare the cyclical behavior of productivity in the model before the change (with the

household structure mimicking the U.S. in 1950) and after the change (the U.S. in 2000). As in the U.S. economy, in the model economy the correlation of productivity and output switches sign from positive to negative, while correlation with hours remains negative, but increases in absolute value. The change in the household structure may explain the labor productivity puzzle.

Higher female labor participation and higher proportion of multiple-earner households contribute to the increase of aggregate labor supply volatility. When I impose the U.S. factual changes in household structure into the model economy, the volatility of hours increases from 1.01 (for calibration consistent with 1950) to 1.36. Similar changes in hours volatility happened in the U.S. economy: it grew from 1.07 in 1950-1979 to 1.32 in 1980-2009.

Existing literature has already offered different explanations to the labor productivity puzzle. McGrattan and Prescott (2012) claim that the puzzle is the result of mismeasurement: as intangible capital plays higher role in the modern world, the measurements of productivity and its cyclical behavior become more biased. Gali and van Rens (2014) focus on the changes in labor market frictions: as frictions decline, employment becomes more responsive to cyclical changes, generating negative relationship of output (and hours) with productivity. This paper offers another explanation which works through higher volatility in hours. But I assume that the source of this higher volatility is more people from two-earner households in the labor force (see Fig. 1) due to changes in household labor division.

The paper also contributes to the discussions of labor supply elasticities (Chetty et al., 2012; Dyrda et al., 2012; Wallenius and Rogerson, 2012; Prescott and Wallenius, 2012) by stressing the household structure as important determinant of labor supply behavior. In two-person households decisions on extensive margin play higher role, generating higher aggregate labor supply elasticity from utility parameters calibrated with micro estimates. Many empirical studies focusing on labor supply elasticity use female gender as an implicit proxy for the secondary earner position and find higher elasticity for female labor supply. To the best of my knowledge, the only empirical study paying attention to the differences between primary and secondary earners is Peterman (2012), finding that secondary earners have more elastic labor supply. This work stresses the differences in labor supply of only, primary and secondary earners.

2 Changes in the Structure of U.S. Households, 1950-2010

After the World War II two major trends shaped the earner structure of American households. One of them is the "quiet revolution" in the socio-economic status of women and higher female labor force participation. The other one is the drop in the marriage rates, accompanied by the increase in divorce rates.

Increasing labor force participation of women is one of the most vivid changes in the socio-economic life of the United States after the World War II. Before the war married women rarely worked. In 1955 only 26.3 per cent of married women were actively working or looking for work; by the year 1990 the number grew to 58.2 per cent and remained fairly constant afterwards. At the same period of time the labor force participation of married men declined slightly from 88.2 per cent in 1955 to 77.3 per cent in 2000¹.

There is no clear consensus in the literature on the main factor contributing to the dramatic increase in the labor force participation of married females. Most often the works cite progress in the home production technologies (Greenwood et al., 2005; Jones et al., 2003), the invention of the pill (Goldin and Katz, 2002) or cultural shifts due to World War II (Fernandez et al., 2004).

The direct consequence of the higher participation of married women is the increase in the proportion of marriages where both partners work, i.e. two-earner married households. The drop in the participation of married men offsets this effect only insignificantly.

Decline in marriage along with the increase in divorce constitute another important feature of the socio-economic development in the post-war U.S.. Between 1950 and 2000 marriages per 1,000 unmarried women fell from 211 to 82; the divorce rates, on the opposite, grew from 11 to 23 per 1,000 married women. As a result, over the same period the share of married women fell from 82 to 62 percent (Greenwood and Guner, 2009).

Part of the decline in marriage was offset by higher cohabitation rates (Lundberg and Pollak, 2013). Nevertheless, late and less common marriages coupled with higher divorce rates lead to the increase in the proportion of single-person and single-parent households.

Table 2 describes the relevant changes in the earner structure of the households from 1950 to 2000. Higher female labor force participation manifests in the increase of the

¹Data in this paragraph are from the U.S. Census Bureau, *Statistical Abstract of the United States*

Table 2: Changes in household structure in the U.S., 1950-2010

		1 adult	2 or more adults	
			1 earner	2 or more earners
1950	15.8%		50.2%	34.0%
2000	21.3%		28.2%	50.5%

Only households with earners are included. Source: Census data from IPUMS-USA

share of households with two or more earners from 34.0% to 50.5%. At the same time the changes in the marriage/divorce trends contributed to the increase in the proportion of households with a single adult and earner.

Depending on the type of the household and the role of a person in the household one can define four different types of agents by the peculiarities of their labor supply. Type I is the primary earner of a single-adult household, whose behavior has been extensively studied in the representative agent models. Her labor supply results from an autonomous choice among consumption, leisure, household production and market work. Type II is the primary earner in the two-person household. Her labor supply decision takes into account the fact that there is another adult in the household taking care of (the part of) household production, and hence, she is less likely to substitute into home production in case of adverse events on the market. Type III is the primary earner in the two (or more)-adult and two(or more)-earner household. While she is the primary breadwinner, she is not the only one, and hence her labor supply might be more elastic than that of Type I or Type II. Type IV, the secondary earner, theoretically is the most elastic type: she can easily substitute into the home production in recessions, as there is no one at home already taking care of it, and there is another, more prolific earner in the household that can compensate for the forgone market earnings.

The socio-economic changes that happened over the course of the last 60 years have significantly shifted the balance on the labor market towards the more elastic types. While Type II earner was a dominant type in 1950, by 2010 Type I, Type III and Type IV increased their presence substantially, changing the aggregate labor dynamics. Unfortunately, empirical studies of labor supply elasticity rarely take into account the household structure and the position of the individual in the household, focusing instead on sex and marital status, which are imperfect proxies.

3 The Model Economy with One- and Two-Earner Households

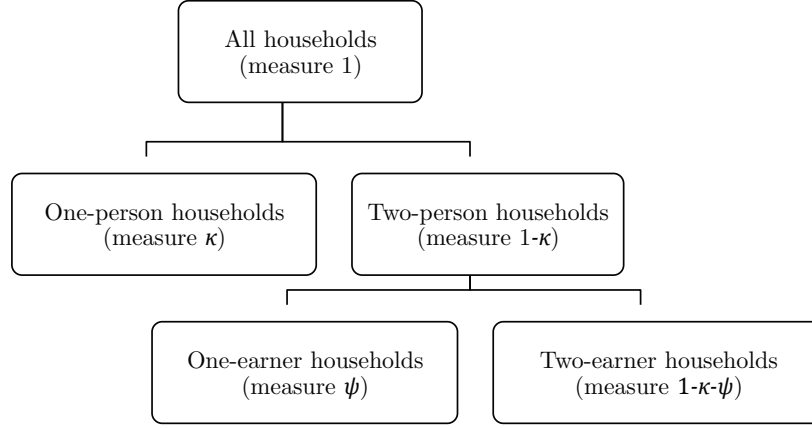
In this section I construct the model with the three types of households - one-person households, two-person one-earner households and two-person two-earner households. All household members within and across households are heterogeneous in labor productivity. However, I abstract from the idiosyncratic productivity shocks and focus on fluctuations in aggregate productivity only.

3.1 Demography

The model economy is populated by a measure 1 of households. Households may be populated by one person only (with the measure of one-person households equal to $\kappa \in (0, 1)$) or by two persons (with the corresponding measure of $1 - \kappa \in (0, 1)$). One-person households and individuals are indexed with i , two-person households with two earners are indexed with j , and $1j$ and $2j$ index the primary and the secondary earner correspondingly. Two-person households with one earner are indexed with k , $1k$ is for the only earner, $2k$ for the stay-at-home agent. I assume that individuals in two-person households have separate utility functions, but they make decisions about individual consumption, market and home work and leisure together, in Pareto-optimal fashion. They also make capital and make saving decisions jointly. Hence the decision-making process can be represented by the maximization of the household utility function.

Each two-person household belongs to one of the two types: it is either a one-earner or a two-earner household. The measure of one-earner households is $\psi \in (0, 1 - \kappa)$. Figure 3.1 depicts the household structure of the model economy. In one-earner household only one person (indexed $1k$) decides how much time to spend on the market and in home production - I impose the restriction of zero market hours for the second person, who may only take part in the home production. In two-earner households both individuals may decide whether to work or not and how many hours to spend working on the market and at home.

Figure 2: Household Structure in the Model Economy



3.2 Preferences of one-person households

A one-person household i is maximizing the discounted flow of the instantaneous utilities with a discount factor β :

$$U_{i,t} = \sum_t^{\infty} \beta^t u_{it} \quad (1)$$

Household i has the instantaneous utility function which depends on consumption and leisure:

$$u_{i,t} = u(c_{i,t}, l_{i,t}) \quad (2)$$

The household (and in this case, individual) utility depends on the individual consumption of the composite good $c_{i,t}$ and individual leisure time $l_{i,t}$. Composite good is a combination of market-produced good consumption $c_{i,t}^m$ and home-produced good consumption $c_{i,t}^h$:

$$c_t = C(c_{m,t}; c_{h,t}) \quad (3)$$

where the function C is strictly increasing and strictly concave.

3.3 Preferences of two-person households

I assume that two-person households have a joint maximization problem. A two-person household j (or k for two-person one-earner household) is maximizing the discounted flow

of the sum of instantaneous utilities of household members $1j$ and $2j$ (or $1k$ and $2k$):

$$U_{j,t} = \sum_t^{\infty} \beta^t (u_{1j,t} + u_{2j,t}) \quad (4)$$

Instantaneous utility functions of household members $1j$ and $2j$ are $u_{1j,t}$ and $u_{2j,t}$, and they depend on individual composite consumption and individual leisure as in Eq. 2. The amounts of leisure can be different for the individuals within the same household. The amount of individual composite consumption, however, is determined by $\frac{c_{j,t}}{1+\chi}$, where $c_{j,t}$ is a total composite consumption of the household j , and $\chi \in (0, 1)$ is the parameter of the economies of scale. $\chi = 1$ if there are no economies of scale in the two-person households, and lower χ implies higher economies.

3.4 Endowments

Each agent is endowed with T units of time each period, and she is free to allocate time among leisure $l_{i,t}$, hours worked at home $h_{i,t}^h$, hours worked in the market $h_{i,t}^m$:

$$T = l_{i,t} + h_{i,t}^m + h_{i,t}^h + \tau \cdot I(i, t) \quad (5)$$

There is a fixed time cost of working τ , the agent only incurs it if she participates in the labor market. I can interpret τ as commuting time. $I(i, t)$ is the indicator function that takes a value of 1 if an agent i is working on the market in period t . The same is true for all the agents in two-person two-earner households and for the agent 1 in the two-person one-earner household. For the stay-at-home agent $2k$ in a two-person one-earner household the hours can be allocated only between home production and leisure:

$$T = l_{2k,t} + h_{2k,t}^h \quad (6)$$

Households of two persons own assets and make investment decisions jointly. At period $t = 0$ each household is endowed with a_0^j units of capital assets. I assume $a_0^j \in (0, \infty)$. Capital depreciates at the rate δ . Capital assets of the household i move according to the following law:

$$a_{t+1}^i = a_t^i(1 - \delta) + i_t^i \quad (7)$$

where i_t^i is investment of the household i and time t .

3.5 Home production and aggregate market technology

Any household also has access to the technology of home production. The home-produced good can be consumed only within the household and can not be invested. To simplify I assume that only labor ($h_{i,t}^h$) is used in home production, and that home production sector is not subject to any shocks. Labor displays diminishing returns. For one-person households the production of home good is given by:

$$c_{i,t}^h = f_h(h_{i,t}^h) \quad (8)$$

For both types of two-person households the amount of home production depends on home hours put in by both household members:

$$c_{j,t}^h = H(h_{1j,t}^h, h_{2j,t}^h) \quad (9)$$

where the function H is increasing in both arguments and strictly concave. Market goods are produced with a Cobb-Douglas production function that is subject to technology shock z_t :

$$Y_t = e^{z_t} K_t^\alpha L_t^{1-\alpha}, \quad \alpha \in (0, 1) \quad (10)$$

Technology shock follows the standard autocorrelation process with the autocorrelation parameter η and variance of the shocks ρ^2 :

$$z_t = \eta z_{t-1} + \epsilon_t, \quad \epsilon \sim N(0, \rho^2) \quad (11)$$

Market good can be consumed or invested. Note that investment good is produced only in the market:

$$Y_t = \int_i (c_{i,t}^m + i_{i,t}) di + \int_j (c_{j,t}^m + i_{j,t}) dj + \int_k (c_{k,t}^m + i_{k,t}) dk \quad (12)$$

4 Calibration

4.1 Functional forms

As in many recent aggregate labor supply studies (Rogerson and Wallenius, 2009; Prescott and Wallenius, 2012) the instantaneous utility function for the one-person household is an additive CES function in consumption and leisure:

$$u_{i,t} = \log c_{it} + \sigma \frac{l_{it}^{1-\gamma}}{1-\gamma} \quad (13)$$

The parameter $\sigma > 0$ specifies the relative value of leisure. The parameter $\gamma > 1$ determines the intertemporal (Frisch) elasticity of labor, which is given by $\frac{1}{\gamma} \frac{l_i}{h_i}$. For the two-person household the instantaneous utility function correspondingly becomes:

$$u_{i,t} = 2 \log \frac{c_{j,t}}{1+\chi} + \sigma \frac{l_{1j,t}^{1-\gamma}}{1-\gamma} + \sigma \frac{l_{2j,t}^{1-\gamma}}{1-\gamma} \quad (14)$$

Composite consumption is a CES aggregation from market consumption and home-produced consumption:

$$C(c_{m,t}; c_{h,t}) = (ac_{m,t}^e + (1-a)c_{h,t}^e)^{1/e}, \quad a \in (0, 1), e \in (-\infty, 1) \quad (15)$$

The parameter a is the weight of market consumption consumption, while the parameter e reflects the elasticity of substitution between market and home-produced goods. This specification is standard in home production literature starting with the seminal work of Benhabib et al. (1991).

The home production technology has decreasing returns to scale in hours worked at home. I omit capital from home production function as the focus of the paper is on labor. For a one-person household i the home production function is:

$$c_i^h(h_{1,h,t}) = h_{i,h,t}^{1-\alpha_1} \quad (16)$$

For a two-person household j the home production function is separably additive in the home hours of the two household members:

$$c_j^h(h_{1j,h,t}, h_{2j,h,t}) = h_{1j,h,t}^{1-\alpha_1} + h_{2j,h,t}^{1-\alpha_1} \quad (17)$$

4.2 Household structure and individual productivities

The parameters governing the household structure (κ and ψ) are calibrated directly from the census data from Integrated Public Use Microdata Series on the U.S. (Ruggles et al., 2010). I used 5% samples from 1950, 1960, 1970, 1980, 1990, 2000 and 2010 to track the evolution of household structure (see 1). As in 2, I will use two sets of household

structure parameters: corresponding to the household structure in 1950 and in 2000 in my simulation exercise.

I use earnings data from CPS (March supplement, 2010) to calibrate individual productivities. Individual productivities are calibrated to reflect hourly labor earnings (wages and salaries plus a fraction of business income, as in Diaz-Gimenez et al. (2011)). Weights for households with certain individual productivities are also assigned from CPS, and I take into account the actual household structure. Since the literature gives a lot of evidence on assortative mating in family formation (the most recent data exploration of assortative matching is in Greenwood et al. (2014)), I take into account the joint distribution of primary and secondary earners in two-earner households. Hence, individual productivities within households are not independently distributed. There are five possible productivity values for one-earner households and 15 productivity value pairs for two-earner households.

4.3 Other parameters

A set of parameters β (discount factor), δ (depreciation rate), η (autocorrelation term for technology shock) and ρ (standard deviation of technology shock) are assigned their conventional values, as in Cooley and Prescott (1995).

Since the focus of this paper is the behavior of hours, main calibration targets are hours worked in the market and at home. I use American Time Use Survey (ATUS) data for 2003-2013 for the source of data on time use. ATUS is a nationally representative survey of non-institutionalized adult population (over 15 years). I define discretionary time as 24 hours less time spent on personal care activities. My broad definition of home work follows Ramey (2009) and includes four ATUS categories: household activities (housework), purchasing goods and services (less personal and medical care), caring for household members, and for non-household members. I define market work as time working, time spent on other work-related and income-generating activities. Time spent on travel related to work (for those who work) is the natural definition of the commuting cost τ .

I use micro estimates of Frisch labor supply elasticity as a target to calibrate γ , the parameter governing elasticity of labor in the model. Domeij and Floden (2006) give estimates of 0.2 to 0.6 for Frisch elasticity of labor supply of males. Estimates of female Frisch elasticity are typically higher, hence I will target Frisch elasticity of 0.5 for all

individuals, a common choice in labor supply literature. The Frisch elasticity in the model economy depends also on the targeted hours worked and hours of leisure.

The parameter e determines the elasticity of substitution between market and home-produced goods. The estimates of this parameter in the literature range from 0.40 to 0.60 (Aguiar and Hurst, 2007; Nevo and Wong, 2014; Chang and Schorfheide, 2002). I choose the value of $e = 0.5$, which corresponds to the elasticity of substitution of 2. The coefficient α_1 in home production function is adopted from Gomme and Rupert (2007).

Two parameters left to calibrate - relative value of leisure σ , share of market good in consumption a , - are selected to match the average hours worked at the market and at home (3.32 and 3.25 hours a day according to ATUS).

Calibrated and chosen values of parameters are summarized in A.

5 Results and Discussion

The presence of two-earner households in the model generates new behavior patterns. The two-earner household may react to a negative technology shock by the exit of the least productive household member from the labor market or with a more rapid contraction in his or her hours (similar mechanism is described in Bornukova (2011) for a representative two-earner household). As a result, the hours of the least productive household member decline more than those of the more productive, and the average productivity of labor supply from that household increases. If the proportion of the two-earner households is high enough, aggregate labor productivity may increase in response to negative technology shocks, rendering labor productivity counter-cyclical.

As the proportion of two-(or more) earner households increases from 34% (as in 1950) to 50.5% (as in 2000), the correlation of aggregate labor productivity with output changes from 0.28 to -0.46 in the model economy. This change is very similar to the one I observe in the U.S. economy over the similar periods (see Table 5).

The negative correlation of productivity with hours worked also becomes more pronounced as a proportion of two-person households grows. While aggregate hours still drop

Table 3: Cyclical behavior of aggregate labor productivity

Correlation of productivity with output		
	1950:q1-1979:q4	1980:q1-2009:q4
The model	0.28	-0.46
The data	0.10	-0.27

Correlation of productivity with hours		
	1950:q1-1979:q4	1980:q1-2009:q4
The model	-0.29	-0.72
The data	-0.38	-0.68

in case of negative technology shock, productivity may increase not only through the decreasing marginal productivity, but also due to the fact that the cut in aggregate hours is mainly the cut in less productive hours.

The model economy captures well another change in the business cycle behavior in the U.S. - the increase in the relative volatility of hours. The volatility of hours relative to output has increased from 1.07 in 1950-1979 to 1.32 in 1980-2009. The corresponding change in the model is from 1.01 to 1.36. The increase in volatility of hours can also be attributed to changes in household structure: both the increase in the proportion of two-earner households and the increase in the proportion of single-adult households contribute to it. The labor supply of Type IV earner, a secondary earner in two-earner household is much more volatile than the labor supply of any other agent type in the model economy (see 5). When comparing two only earners in the households: Type I and Type II, one may see that the volatility of labor supply depends a lot on the household type of the earner. If the only earner is not the only person in the household, volatility of her labor supply is very low: her ability to substitute into home production is limited by the fact that another household member is already taking care of it. The only earner in the one-person household is more free to substitute into home production and leisure during bad times. The increase in the proportion of Type I and Type IV earners contributes to higher volatility of aggregate labor supply.

The complete set of the business cycle statistics of the model economy with two different household structures can be found in Appendix B.

Table 4: Volatilities of labor supply by types in the model economy

		St. Dev
Type I	Earner in single-person household	2.91
Type II	Single earner in two-person household	0.31
Type III	Primary earner in two-earner household	1.65
Type IV	Secondary earner in two-earner household	4.83

Labor supply is aggregated by types. Based on decision rules in the 2000's structure of model economy. All variables are logged and detrended with HP filter

6 Concluding Remarks

The increase in female labor force participation and the resulting change in household structure had important consequences for labor supply. I show that the increase in the proportion of the multiple-earner households may be the explanation behind the change in the cyclical behavior of productivity in the U.S. In recessions the multiple-earner household may adjust by the significant reduction of the market hours worked by the least productive member. If the share of multiple earner households is high enough, the aggregate labor productivity becomes counter-cyclical.

I build a model economy consisting of one- and two-earner households with agents different in productivity. I impose the household structure change in the model economy, which corresponds to the changes in the U.S. in 1950-2000. The behavior of the aggregate labor productivity in the model changes similarly to how it changed in the U.S. data. In particular the correlation between productivity and output becomes negative as the share of multiple-earner households increases.

I also show that the household structure and the role of the individual within the household have implications for the behavior of labor supply, in particular for its volatility. For example, secondary earners have higher labor supply volatility. Primary earners from the multiple-earner households are also more elastic than the only earners. As the share of multiple-earner households increases, the volatility of aggregate labor supply goes up. In the model economy the increase in the proportion of two-earner households (corresponding to the actual increase in the U.S. from 1950 to 2000) leads to the 30% increase in the volatility of aggregate hours, as in the data.

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A Calibrated Parameter Values

Parameter		Value	Calibration source or target
Relative value of leisure	σ	0.41	To match hours worked
Share of market good in consumption	a	0.12	To match hours worked
Frisch elasticity	γ	2.41	To match Frisch elasticity of 0.5
Labor share in home production	$1 - \alpha_1$	0.62	Gomme and Rupert (2007)
Time endowment	T	1.00	normalized to 1
Commuting cost	τ	0	directly from the data
Substitution between c_m and c_h	e	0.50	
Discount factor	β	0.99	conventional value
Depreciation rate	δ	0.03	conventional value
Autocorrelation of technology shock	η	0.95	conventional value
St.d. of technology shock	ρ	0.01	conventional value
Capital share	α	0.36	conventional value

B Business Cycle Statistics of The Model Economies

Volatility relative to output, 1980:q1-2009:q4

	1950:q1-1979:q4		1980:q1-2009:q4	
	The data	The model	The data	The model
Consumption	0.81	0.88	0.80	0.85
Investment	4.50	3.80	5.25	4.62
Hours	1.07	1.01	1.32	1.36
Productivity	0.51	0.55	0.64	0.54

Correlations with output, 1980:q1-2009:q4

	1950:q1-1979:q4		1980:q1-2009:q4	
	The data	The model	The data	The model
Consumption	0.77	0.85	0.86	0.81
Investment	0.82	0.79	0.91	0.91
Hours	0.88	0.84	0.88	0.93
Productivity	0.10	0.28	-0.27	-0.46

Correlation of productivity with output

	1950:q1-1979:q4	1980:q1-2009:q4
The model	0.28	-0.46
The data	0.10	-0.27

Correlation of productivity with hours

	1950:q1-1979:q4	1980:q1-2009:q4
The model	-0.29	-0.72
The data	-0.38	-0.68